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APPLICATION FOR UNITED STATES LETTERS PATENT FOR

ANTENNA UNIT AND WIRELESS COMMUNICATION APPARATUS

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ANTENNA UNIT AND WIRELESS COMMUNICATION APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates, in general, to an antenna unit and a wireless communication apparatus. More particularly, the present invention relates to an antenna unit which is provided in a wireless communication apparatus for performing wireless communication, and in which variations in antenna characteristics depending on surrounding parts are limited, and to a wireless communication apparatus using the antenna unit.

Description of Related Art

In recent years, information processors such as personal computers and PDAs incorporating wireless LAN functions and standards such as IEEE802.11a/b/g and Bluetooth® have come into wide use. In information processors having wireless LAN functions, it is desirable to realize an antenna such that the influence of internal parts or the like of the information processor on the antenna is reduced and the antenna has stable characteristics.

As a method for limiting the influence of noise or the like from an information processor on an antenna, a method of using, for example, a shielding member of a display panel as a ground circuit for an antenna has been proposed (for instance see Published Unexamined Japanese Patent Application Laid-Open No. 2000-174527).

In certain of the wireless LAN functions, such as IEEE802.11a/b/g and Bluetooth, different frequency bands in accordance with the standards may be used and, therefore, it is often desirable to realize or utilize all the frequency bands by one antenna. In order to achieve this, it is necessary to determine characteristics of the antenna including impedance with higher accuracy at the time of manufacturing and assembly.

However, in a case where one antenna is used in concert with a system utilizing in a plurality of information processor types, the characteristics of the antenna are often changed for a variety of

reasons including the position or location of parts and the arrangement of the display panel, each of which may also be dependent on the particular kind of processor used. For example, in one information processor, the characteristics of the antenna may be affected by variations in the position of certain parts and wiring, whereas if another information processor were used, similar effects would not be realized.

SUMMARY OF THE INVENTION

Accordingly, there is a need for an invention that overcomes the problems discussed above. The present invention has been achieved to solve the above technical problems, and accordingly an object of the present invention is to provide an antenna unit and a wireless communication apparatus capable of solving the above-described problems.

According to a first aspect of the present invention, there is provided an antenna unit in a wireless communication apparatus which performs wireless communication, the antenna unit having a radio wave resonance part through which a radio wave is transmitted or received, an antenna ground part electrically connected to the radio wave resonance part, and a connection part which fixes the antenna ground part in such a position that the antenna ground part is closer to the radio wave resonance part than other ground parts of the wireless communication apparatus.

According to a second aspect of the present invention, there is provided an antenna unit in a wireless communication apparatus which performs wireless communication, the antenna unit having a radio wave resonance part through which a radio wave is transmitted or received, an antenna ground part connected to ground, and a connection part which fixes the antenna ground part in such a position that the antenna ground part is closer to the radio wave resonance part than other ground parts of the wireless communication apparatus, and a feeder laid to the radio wave resonance part at a distance from the antenna ground part, a shielding conductor of the feeder being connected to the antenna ground part on the opposite side of the antenna ground part from the radio wave resonance part, a signal conductor of the feeder being connected to the radio wave resonance part.

According to a third aspect of the present invention, there is provided a wireless communication

apparatus which performs wireless communication, the apparatus having a radio wave resonance part through which a radio wave is transmitted or received, an antenna ground part electrically connected to the radio wave resonance part, and a connection part which fixes the antenna ground part in such a position that the antenna ground part is closer to the radio wave resonance part than other ground parts of the wireless communication apparatus.

According to a fourth aspect of the present invention, there is provided wireless communication apparatus which performs wireless communication, the apparatus having a radio wave resonance part through which a radio wave is transmitted or received, an antenna ground part connected to ground, and a connection part which fixes the antenna ground part in such a position that the antenna ground part is closer to the radio wave resonance part than other ground parts of the wireless communication apparatus, and a feeder laid to the radio wave resonance part at a distance from the antenna ground part, a shielding conductor of the feeder being connected to the antenna ground part on the opposite side of the antenna ground part from the radio wave resonance part, a signal conductor of the feeder being connected to the radio wave resonance part.

BRIEF DESCRIPTION OF THE DRAWINGS

Other aspects, features, and advantages of the present invention will become more fully apparent from the following detailed description, the appended claims, and the accompanying drawings in which:

Figure 1 shows the structure of an information processor 100 in accordance with an embodiment of the present invention;

Figure 2 shows the structure of an antenna unit 200a in accordance with an embodiment of the present invention;

Figure 2(a) is a view of the antenna unit 200a in accordance with an embodiment of the present invention as seen from the input portion 110 side of a display portion 120;

Figure 2(b) is a view of the antenna unit 200a in accordance with an embodiment of the present

invention as seen in a direction toward a side surface of the display portion 120;

Figure 2(c) is a perspective view of the antenna unit 200a in accordance with an embodiment of the present invention;

Figure 3 shows the structure of an antenna unit 200b in accordance with an embodiment of the present invention;

Figure 3(a) is a view of the antenna unit 200b in accordance with an embodiment of the present invention as seen from the input portion 110 side of the display portion 120;

Figure 3(b) is a view of the antenna unit 200b in accordance with an embodiment of the present invention as seen in a direction toward a side surface of the display portion 120;

Figure 3(c) is a perspective view of the antenna unit 200b in accordance with an embodiment of the present invention;

Figure 4 shows the configuration of an antenna part 205 which is a part for the antenna units 200a and 200b in accordance with an embodiment of the present invention;

Figure 5 shows voltage standing wave ratio (VSWR) characteristics of an antenna not having the antenna ground part 220 in accordance with an embodiment of the present invention; and

Figure 6 shows VSWR characteristics of the antenna unit 200 in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

The use of figure reference labels in the claims is intended to identify one or more possible embodiments of the claimed subject matter in order to facilitate the interpretation of the claims. Such labeling is not to be construed as necessarily limiting the scope of those claims to the embodiments shown in the corresponding figures. The preferred embodiments of the present

invention and its advantages are best understood by referring to the drawings, like numerals being used for like and corresponding parts of the various drawings. Embodiments of the present invention will now be described in detail with reference to the accompanying drawings, wherein the embodiments described below, however, are not limiting to the invention set forth and all combinations of features described in any of the descriptions of any embodiment are not necessarily indispensable to the solution according to the present invention.

Figure 1 shows the structure of an information processor 100 in accordance with an embodiment of the present invention. The information processor 100 is an example of the wireless communication apparatus in accordance with the present invention. The information processor 100 performs wireless communication with another unit. The information processor 100 has an input portion 110 through which an operation performed by a user of the information processor 100 is received as an input, a display portion 120 through which information is output to the user of the information processor 100, a hinge portions 130 for connecting the display portion 120 to the input portion 110 in a hinged manner to accommodate the opening or closing of the display, a communication circuit 140 which generates a signal to be transmitted in wireless communication, and which converts a signal received in wireless communication into data used by the information processor 100, and antenna units 200a and 200b each of which radiates a wireless communication radio wave by being supplied with a signal generated by the communication circuit 140, and each of which supplies the communication circuit 140 with a signal received in wireless communication.

The information processor 100 in this embodiment is used, for example, in common for wireless communication in the 5 GHz band used in IEEE802.11a and for wireless communication in the 2.45 GHz band used in IEEE802.11 b/g and Bluetooth. The high-performance antenna units 200a and 200b designed so that variations in characteristics depending on the kinds of information processor 100, variations in the positions of parts and wiring, etc., are limited are provided to realize high wireless communication performance.

Figure 2 shows the structure of the antenna unit 200a in accordance with an embodiment of the present invention. Figure 2(a) is a view of the antenna unit 200a in accordance with an embodiment of the present invention as seen from the input portion 110 side of the display portion 120. Figure 2(b) is a view of the antenna unit 200a in accordance with an embodiment of the present invention as seen in a direction toward a side surface of the display portion 120. Figure 2(c) is a perspective

view of the antenna unit 200a in accordance with an embodiment of the present invention.

The antenna unit 200a is provided on a side surface on the right as one faces the display surface of the display portion 120. The antenna unit 200a is used in common for wireless communication in a first frequency band, e.g., the 2.45 GHz band and for wireless communication in a second frequency band, e.g., the 5 GHz band. The antenna unit 200a has a radio wave resonance part 210a, an antenna ground part 220a, a connection part 230a, a feeder 240a, and a reinforcing member 250a.

The radio wave resonance part 210a transmits/receives radio waves. The radio wave resonance part 210a receives electric signal to be transmitted from the communication circuit 140 by resonating with the signal to transmit a radio wave, and receives a wireless communication radio wave by resonating with the radio wave to supply a radio wave signal to the communication circuit 140. The radio wave resonance part 210a is used in common in the first and second frequency bands for transmission and reception of radio waves. However, the radio wave resonance part 210a is designed so as to be most suitable for wireless communication in the first frequency band.

The radio wave resonance part 210a includes a radio wave resonance side part 214a which extends from the antenna ground part 220a along the display direction of the display portion 120, and a radio wave resonance upper part 212a which extends from the radio wave resonance side part 214a so as to be closer to the display portion 120. In this embodiment, the radio wave resonance upper part 212a is opposed to the antenna ground part 220a in a state of extending generally parallel to the antenna ground part 220a. The radio wave resonance side part 214a in this embodiment has at least its portion extended in a direction along a longer side of the radio wave resonance upper part 212a, its one end connected to the antenna ground part 220a, and the other end connected to the radio wave resonance upper part 212a. The radio wave resonance upper part 212a and the radio wave resonance side part 214a form a generally U-shaped member.

The radio wave resonance upper part 212a functions as a first radio wave resonance element in accordance with the present invention and is used for transmission and reception of a radio wave of a first frequency in the first frequency band. On the other hand, the radio wave resonance side part 214a functions as a second radio wave resonance element in accordance with the present

invention and is used for transmission and reception of a radio wave of a second frequency in the second frequency band. The first frequency is lower than the second frequency, and the radio wave resonance upper part 212a is used for transmission or reception of a radio wave of a longer wavelength in comparison with the radio wave resonance side part 214a.

The antenna ground part 220a is electrically connected to the radio wave resonance part 210a and functions as a ground surface connected to ground. The antenna ground part 220a may be electrically connected by being formed integrally with the radio wave resonance part 210a. In such a case, the antenna ground part 220a may be formed by pressing from one sheet metal as a part integral with the radio wave resonance part 210a. Alternatively, the antenna ground part 220a may be cast in one die as a part integral with the radio wave resonance part 210a. In this embodiment, the antenna ground part 220a has such a trapezoidal shape that the longer one of its parallel sides is adjacent and parallel to a side surface of the display portion 120.

The antenna ground part 220a extends outward from the side surface of the display portion 120 away from the display portion 120 generally parallel to the display surface of the display portion 120. The radio wave resonance part 210a is provided at the side of the antenna ground part 220a remoter from the display portion 120. Consequently, the antenna ground part 220a can prevent the radio wave resonance part 210a from being influenced by the feeder 240a laid along the side surface of the display portion 120.

It is desirable that the antenna ground part 220a be positioned adjacent to a region on the display direction side of the display surface of the display portion 120 (i.e., on the radio wave resonance part 210a side) and on the display surface 120 side of the radio wave resonance part 210a, as shown in Figure 2(a), thereby enabling the antenna ground part 220a to prevent the radio wave resonance part 210a from being influenced by signal conductors, a ground part, etc., in the display portion 120.

The connection part 230a fixes the antenna ground part 220a so that the antenna ground part 220a is positioned closer to the connection part 230a than ground parts of the information processor 100 other than the antenna ground part 220a, e.g., the display portion 120. By fixing the antenna ground part 220a in this manner, the connection part 230a can prevent the characteristics of the antenna unit 200a from being influenced by another ground part etc., of the information processor 100. The connection part 230a may be formed integrally with the radio wave resonance part 210a and the

antenna ground part 220a. The connection part 230a includes a feeder fixing part 260a for fixing the feeder 240a on the connection part 230a and attachment holes 270a which are screw holes or the like for fixing the antenna unit 200a on the display portion 120.

The feeder 240a is a wiring line, e.g., a coaxial cable or the like which connects the communication circuit 140 and the antenna unit 200a. The feeder 240a is laid to the radio wave resonance part 210a at a distance from the antenna ground part 220a. A shielding conductor in the feeder 240a is connected to the antenna ground part 220a at a shielding connection part 242a on the opposite side of the antenna ground part 220a from the radio wave resonance part 210a. In this manner, the antenna characteristics of the radio wave resonance part 210a can be prevented from being affected by variation in the laid position of the feeder 240a or variation in the state of the connection made by soldering or the like at the shielding connection part 242a.

A signal conductor which is a core conductor of the feeder 240a extends from the shielding connection part 242a to be connected to the radio wave resonance part 210a at a signal connection part 244a. The signal conductor of the feeder 240a is laid to the signal connection part 244a from an end of the antenna ground part 220a in a direction along the side surface direction of the display portion 120, which end is closer to the signal connection part 244a. In this manner, the influence of the core conductor of the feeder 240a on the antenna characteristics of the radio wave resonance part 210a can be limited.

The reinforcing member 250a is provided between the radio wave resonance upper part 212a, which is a flat portion in the radio wave resonance part 210a parallel to the antenna ground part 220a, and the antenna ground part 220a to maintain the spacing between the radio wave resonance upper part 212a and the antenna ground part 220a at a design value and to reinforce the antenna unit 200a. For ease of illustration, the reinforcing member 250a is omitted in the Figures 2(a) and 2(c).

Figure 3 shows the structure of the antenna unit 200b in accordance with an embodiment of the present invention. Figure 3(a) is a view of the antenna unit 200b in accordance with an embodiment of the present invention as seen from the input portion 110 side of the display portion 120. Figure 3(b) is a view of the antenna unit 200b in accordance with an embodiment of the present invention as seen in a direction toward a side surface of the display portion 120. Figure 3(c) is a perspective

view of the antenna unit 200b in accordance with an embodiment of the present invention.

The antenna unit 200b is provided on a side surface on the left as one faces the display surface of the display portion 120. The antenna unit 200b is used in common for wireless communication in the first frequency band and for wireless communication in the second frequency band. The antenna unit 200b has an approximately symmetrical relationship with the antenna unit 200a with respect to the display portion 120. The antenna unit 200b has a radio wave resonance part 210b, an antenna ground part 220b, a connection part 230b, a feeder 240b, and a reinforcing member 250b. These parts of the antenna unit 200b have the same structures and functions as those of the corresponding parts of the antenna unit 200a.

The radio wave resonance part 210b is used in common in the first and second frequency bands for transmission and reception of radio waves, as is the radio wave resonance part 210a. The radio wave resonance part 210b is designed so as to be most suitable for wireless communication in the second frequency band. The gain of the radio wave resonance part 210b in the first frequency band is lower than that of the radio wave resonance part 210a, while the gain of the radio wave resonance part 210b in the second frequency band is higher than that of the radio wave resonance part 210a. Therefore the communication circuit 140 can perform wireless communication by selecting the antenna unit 200 from the antenna units 200a and 200b, with which higher wireless communication performance can be achieved.

The antenna unit 200b arranged to realize the above-described different characteristics differs from the antenna unit 200a in the following respects. The radio wave resonance upper part 212b is shorter than the radio wave resonance upper part 212a and is formed in such a manner that an end portion of the radio wave resonance upper part 212a at a side where the upper part is not connected to the radio wave resonance side part 214a is removed. The radio wave resonance side part 214b is formed in such a manner that its portion closer to the antenna ground part 220b in an end portion connected to the radio wave resonance upper part 212b is removed in comparison with the corresponding portion of the radio wave resonance side part 214a. For impedance matching with respect to a difference in impedance due to these points of difference, the signal connection part 244b is provided at an intermediate portion in the radio wave resonance side part 214b in the direction along the longer side of the radio wave resonance upper part 212b.

Figure 4 shows the configuration of an antenna part 205 which is a part for the antenna unit 200a and 200b in accordance with an embodiment of the present invention. The antenna part 205 in this embodiment is formed by pressing from one sheet metal.

When the antenna part 205 is used as the antenna unit 200a, it is worked as described below. First, a portion 400a to be removed, which is a portion closer to an antenna ground part 220, is removed from a radio wave resonance side part 214 at an end at which the radio wave resonance side part 214 is connected to a radio wave resonance upper part 212. The radio wave resonance side part 214b is thereby formed so that the portion corresponding to the portion 400a to be removed in the radio wave resonance side part 214a is removed. A feeder fixing part 260 is bent toward the back surface of a connection part 230 as seen in the frontal direction of the figure to hold the feeder 240a, and the antenna ground part 220 is bent rearward relative to the connection part 230 so as to be approximately perpendicular to the connection part 230.

The radio wave resonance side part 214 is bent frontward relative to the antenna ground part 220 so as to be approximately perpendicular to the antenna ground part 220, and the radio wave resonance upper part 212 is bent frontward relative to the radio wave resonance side part 214 so as to be approximately perpendicular to the radio wave resonance side part 214.

When, the antenna part 205 is used as the antenna unit 200b, it is worked as described below. First, a portion 400b to be removed, which is a portion at an end at which the radio wave resonance upper part 212 is not connected to the radio wave resonance side part 214, is removed. The radio wave resonance upper part 212b is thereby formed so that the portion corresponding to the portion 400b to be removed in the radio wave resonance upper part 212a is removed. The feeder fixing part 260 is bent frontward relative to the connection part 230 as seen in the frontal direction of the figure to hold the feeder 240b, and the antenna ground part 220 is bent frontward relative to the connection part 230 so as to be approximately perpendicular to the connection part 230.

The radio wave resonance side part 214 is bent rearward relative to the antenna ground part 220 so as to be approximately perpendicular to the antenna ground part 220, and the radio wave resonance upper part 212 is bent rearward relative to the radio wave resonance side part 214 so as to be approximately perpendicular to the radio wave resonance side part 214.

The antenna ground part 220 and the radio wave resonance part 210 are integrally formed from the antenna part 205. In this manner, the antenna characteristics can be prevented from being varied due to an error in the mount position of the antenna ground part 220 with respect to the radio wave resonance part 210, variation in the amount of solder in the case of mounting the radio wave resonance part 210 to the antenna ground part 220 by soldering, etc.
Figure 5 shows voltage standing wave ratio (VSWR) characteristics of an antenna not having the antenna ground part 220. Figure 6 shows VSWR characteristics of the antenna unit 200a in this embodiment. Each of Figures 5 and 6 shows VSWR characteristics in the 2.45 GHz band of models A, B, and C in a case where a display panel X (liquid crystal display X) is mounted and in a case where a display panel Y (liquid crystal display Y) is mounted.

In the case where the antenna ground part 220 is not provided, the VSWR characteristic varies largely depending on the model and the kind of the display panel. In particular, due to the difference between the display panels, the frequency at which the VSWR is minimized changes largely in the range from about 2.4 GHz to about 2.5 GHz. This shows that the antenna impedance varies due to the difference between the display panels in the case of use of one antenna. In the 2.45 GHz band, the frequency band used for wireless communication has a bandwidth of 100 MHz. Therefore, antennas not having the antenna ground part 220 individually need impedance matching, for example, by changing the position of the signal connection part 244a according to the model of the information processor 100 and the kind of the display portion 120.

In the case of the antenna unit 200a, variations in the VSWR characteristic depending on the models and the kind of the display panel are limited in comparison with the case where the antenna ground part 220 is not provided. In particular, even when the display panel is changed, the change in the frequency at which the VSWR is minimized can be limited within the range from about 2.45 GHz to about 2.47 GHz. Consequently, the antenna unit 200a is capable of limiting the VSWR to 1.5 or less in the range from 2.4 GHz to 2.5 GHz, and favorable communication characteristics can be provided by using the same antenna unit 200a regardless of the models of the information processor 100 and the kind of the display panel 120.

While the present invention has been described with respect to the embodiment, the technical scope of the present invention is not limited to the scope described above with respect to the various embodiments. Various changes and modifications can be made in the above-described

embodiment. From the description of the appended claims, it is apparent that forms of the present invention including such changes or modifications are also included in the technical scope of the present invention.